

Response to Comment by Rabilloud on “Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power”

The critique by Rabilloud¹—whose only listed professional affiliation is an antinuclear activist group—is grossly biased and contains numerous misleading, hyperbolic, and erroneous claims about our paper² and about nuclear energy in general. The nature of his comments bears a striking resemblance to the fallacious reasoning commonly employed by climate change deniers to try to undermine public concern about the climate crisis. Specifically, he resorts to cherry-picking of information and diversionary (red herring) arguments, demands unrealistic exactness, and cites untrustworthy sources. None of his claims undermine any of the key results of our paper, most notably our conclusion that nuclear energy has prevented, and can continue to prevent, a very high number of fatalities and very large greenhouse gas emissions due to fossil fuel burning. It follows that, as uncomfortable as it is for many well-intentioned environmentalists to admit, efforts to undermine nuclear energy also undermine mitigation of climate change and air pollution, with a heavy cost in human lives and potentially disastrous future climate change.

Rabilloud's first section relates mainly to the mortality factor we used to convert historical and projected nuclear energy to number of fatalities. Here he demands exactness/perfection in an inherently approximate set of computations—much as climate deniers do with, for example, climate model computations (and much as deniers of biological evolution demand a perfect fossil record). However, no such mortality factor can be exact and no approach can be perfect, especially if it is based on specific case studies, as is the case with the ExternE approach used in the source we cited for all of our mortality factors.³ As with any type of scientific modeling of complex issues, some level of generalization or parametrization based on specific empirical data is inevitably necessary.

Rabilloud's essential claim is that our nuclear mortality factor does not capture time-dependent impacts. Our paper acknowledges that our mortality and greenhouse gas (GHG) emission factors are implicitly time-invariant. Indeed, no conversion factor normalized to a particular time-independent unit (in our case, unit electric energy produced) can fully reflect transient impacts. Thus our discussion of computation results focuses mainly on time-integrated impacts. Moreover, we separately discuss each of the three major real-world accidents.

Rabilloud also suggests that our nuclear mortality factor is too low and therefore our results for prevented mortality and prevented GHG emissions for the historical period are overestimates. However, his red herring arguments overlook two key facts: first, our coal mortality factor is almost 400 times higher than our nuclear mortality factor; and second, electricity from coal comprises ~95% of our historical replacement scenario. For these and other reasons discussed in our paper, our results for prevented historical impacts are more likely to be underestimates than overestimates. Furthermore, it is inconceivable that future nuclear plants will employ such an

egregiously flawed design as Chernobyl (or even Fukushima). Future generations of reactors are likely to possess a lower mortality factor than the one we employed. Thus, our results for the projection period are also conservative.

We reiterate here that in ~50 years of world nuclear energy production, the April 1986 Chernobyl accident is the only source of fatalities from radiation fallout.² The most authoritative scientific and intergovernmental sources, using extensive empirical data, find a death toll 20 years after the accident of less than 50 people^{4,5}—yet antinuclear people, without providing any credible scientific evidence, arbitrarily assert higher numbers by several orders of magnitude.

Rabilloud's second section focuses on past and projected deaths from Chernobyl and human health effects of low doses of ionizing radiation. He twice asserts that the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) believes that the ultimate death toll from Chernobyl will be ~9000 people. This is outright false. Although the 2006 Chernobyl Forum report⁴ did suggest a possible future death toll of ~4000 people due to fatal cancers resulting from the accident, the 2008 UNSCEAR report⁵ *does not quantify future mortality due to Chernobyl*. Authors of the latter report decided against providing such numbers “because of unacceptable uncertainties in the predictions” (p 64 of ref 5). The report goes on to state, “The use of theoretical projections is fraught with difficulty. It is extremely difficult to communicate such projections accurately and honestly to officials and the general public” (pp 65–66).

Both of these reports are careful to acknowledge that precise quantification and detection of eventual mortality due to Chernobyl is practically impossible, largely due to inherent uncertainties in the models used in such projections, but also because of a reduction in average lifespan in the affected regions for reasons unrelated to the accident.

On a more minor note, Rabilloud claims that no scientists from two of the three most affected countries, Belarus and Ukraine, were involved in the 2008 UNSCEAR report. This, too, is incorrect, as two scientists from these countries are listed in the Acknowledgments (p 66 of ref 5) as having contributed to the report: J. Kenigsberg of Belarus and I. Likhtarev of Ukraine. Kenigsberg is the current representative of Belarus to UNSCEAR (see the UNSCEAR Web site: http://www.unscear.org/unscear/about_us/memberstates.html; accessed Oct. 2013).

Rabilloud acknowledges that there are in fact “crucial uncertainties” regarding the health effects of low doses of ionizing radiation. He then insinuates that we “conveniently” cited the lowest death toll from Chernobyl, apparently because our source for that value was the 2008 UNSCEAR report,⁵ which is the most recent UN assessment of the issue. This is

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the accepted procedure when subsequent reports account for the earlier ones—just as climate scientists cite the most recent Intergovernmental Panel on Climate Change (IPCC) assessment. In contrast, Rabilloud has no qualms with citing and endorsing references that provide outlandishly high estimates (see below), an approach that is a common tactic among antinuclear individuals.

Rabilloud's approach seems to be the classic cherry-picking method, choosing information to match preconceived notions—in this case, the idea that nuclear energy must be very dangerous. This is similar to the way climate change deniers cherry-pick data and cite work and opinions of others who dispute the fundamental scientific consensus reflected in IPCC assessment reports, regardless of how discredited those results and views may be. The IPCC and UNSCEAR reports reflect careful scientific review of the relevant literature by an international group of expert scientists. In contrast, Rabilloud and like-minded people select sources whose findings match their preconceptions about Chernobyl and nuclear energy in general, reflecting a denialist refusal to believe the low death toll found in the several UN assessments.

Close examination of Rabilloud's sources reveals them to be highly dubious. Almost half of them are overtly biased and unreliable, including antinuclear activist groups or individuals (his refs 17, 18–21, 30, 32, 34), unscholarly Internet material (his refs 15, 25, 27, and 37), and newspaper articles (his refs 12, 13, 29).

Rabilloud's refs 18–21 are central to his endorsement of the supra-linear model of the dose–response relationship to ionizing radiation, which suggests that low doses are more harmful than assumed in the commonly adopted linear no-threshold (LNT) model. These four sources are from an official-sounding committee whose core methodology was refuted by the U.K. Health Protection Agency in 2003, which described the methodology as arbitrary and lacking a sound scientific basis.⁶

Rabilloud's ref 22, which he cites to support an outlandish claim that the *historic* death toll from Chernobyl is 500 000–1 000 000 people, is a book that has been discredited for its severely flawed and unscientific methodology and conclusions by several relevant experts, including the lead scientist on the 2008 UNSCEAR report, M. Balonov.⁷

In summary, Rabilloud relies primarily on contrarians who dispute the consensus reports of the Chernobyl Forum⁴ and UNSCEAR.⁵ His approach has a striking similarity to that of climate change deniers and those who deny the overwhelming scientific evidence for biological evolution or the causal connections between smoking and lung cancer, vaccines and reduced mortality, and HIV and AIDS, choosing instead to believe outlier scientists who dispute the mainstream scientific consensus.

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